THE EFFECT OF THE GRAZING GASTROPOD *BEMBICIUM NANUM* ON RECOLONIZATION OF ALGAE ON AN INTERTIDAL ROCK PLATFORM

HAL BRALEY[1], TREVOR A. ANDERSON[1,3] AND G. P. QUINN[2]

[1]Department of Biological Sciences, Deakin University, Geelong, Victoria 3217
[2]Department of Botany and Zoology, Monash University, Clayton, Victoria 3168
[3]Address for reprints

BRALEY, H., ANDERSON, T. A. & QUINN, G. P., 1991:06:30. The effect of the grazing gastropod *Bembicium nanum* on recolonization of algae on an intertidal rock platform. *Proceedings of the Royal Society of Victoria* 103 (1): 13–16. ISSN 0035-9211.

The predominant organisms found in the littoral zone of a rock platform at Aireys Inlet, Victoria, were surveyed in autumn 1989. The predominant algal species was the brown alga *Hormosira banksii*, while the predominant invertebrate herbivore was *Bembicium nanum*. The abundances of *H. banksii* and *B. nanum* were negatively correlated. *B. nanum* had a significant effect on recolonization of the ephemeral brown alga *Scytosiphon lomentaria* but there was no effect on recolonization of *H. banksii* or of the green alga *Enteromorpha intestinalis*.

MANY RECENT studies have described the structure of intertidal communities (Cubit 1984, Lubchenco 1980, 1983, Lubchenco & Cubit 1980, Underwood 1980, 1984, Underwood & Jernakoff 1981). Many of these studies have shown that the structure of an intertidal algal community is affected by both the physical environment (including such factors as immersion) and by grazing, which may eliminate algae above a certain level on the shore (Jernakoff 1983, Steneck 1982, Underwood 1980). Whilst many experiments have examined competition between intertidal herbivores (Fletcher & Creese 1985, Fletcher & Underwood 1987, Quinn & Ryan 1989, Underwood 1984), relatively few have examined specific algal-herbivore interactions (Hunter & Hunter 1983, Underwood 1980, Underwood & Jernakoff 1981) and fewer still have been conducted in Victoria.

An initial survey of a rocky intertidal platform at Aireys Inlet, Victoria, showed a significant negative correlation between the density of the littorinid snail *Bembicium nanum* and the abundance of the predominant algal species *Hormosira banksii*. Previous studies have observed that this littorinid snail grazes micro and ephemeral algae (Quinn & Ryan 1989, Underwood 1980, 1984). A study was conducted to examine the effects of the presence of *B. nanum* upon the recolonisation of *H. banksii* and two species of ephemeral algae, *Enteromorpha intestinalis* and *Scytosiphon lomentaria*.

STUDY SITE AND METHODS

The study site was a sandstone and clay intertidal platform located at Aireys Inlet, Victoria. The platform extends from the sublittoral zone to the high water mark.

Initial Survey

An initial study was conducted to determine the abundance and total number of algae and herbivores present. Twenty one-metre square quadrats were selected randomly and the organisms within the quadrats counted. Correlation analyses were then performed between the number of plants present and the number of herbivores (Zar 1984).

Major Study

Twenty areas each measuring 200 × 200 mm were randomly selected over the rock platform. The substratum within these areas was cleaned to bare rock by scraping with a metal implement and scrubbing vigorously with a domestic scrubbing brush. The experimental areas were then bounded by a layer of antifouling paint (25% $CuSO_4$). Nineteen *B. nanum* (the maximum density of *B. nanum* found) were placed into each of 10 areas (inclusion) whilst all benthic herbivores were excluded from the remaining 10 areas (exclusion).

The enclosures were monitored weekly (or as close as tides and weather would permit) for eight weeks between mid April and early June 1989. On each visit, where necessary, animals were replaced in test areas. The number of plants and algal species were recorded at each visit, and colour photographs were taken at fortnightly intervals to aid analysis of algal abundance. Variation in the mass of organic material in each experimental area was determined at the end of the experimental period. The central four centimetre square portion of each experimental area was scraped with a razor blade and the scrapings dried at 50° C for 24 hours. After weighing to the nearest 0.1 mg, the scrapings were ashed at 550° C for 24 hours and re-weighed. The loss in weight was attributed to organic matter. Analysis of variance was performed on log-transformed plant numbers and on log-transformed dry weights of organic matter found after 8 weeks in test versus control area.

RESULTS

Initial Survey

Table 1 shows the abundance of predominant organisms in the littoral zone of the rock platform. The alga *Hormosira banksii* was the predominant species, covering 100% of the substratum in the lower zones, but becoming patchy and sparse in the higher zones. Small amounts of *Ulva lactuca* and *Corallina* spp. were found but no *Scytosiphon lomentaria* or *Enteromorpha intestinalis* were found in this survey. The most numerous herbivore present was *B. nanum*, averaging 98.8 animals/m^2 and reaching densities up to 473 animals/m^2 in some areas. The pulmonate limpet *Siphonaria diemenensis* was also found in large numbers. A significant negative correlation was recorded between *H. banksii* and *B. nanum* ($r = -0.705$, $df = 18$, $P < 0.001$). No other significant correlations were found.

Species	Mean	SE
Hormosira banksii	159.0	32.8
Ulva lactuca	2.8	1.2
Corallina spp.	1.2	0.8
Siphonaria diemenensis	63.9	17.2
Austracochlea constricta	3.7	1.4
Bembicium nanum	98.8	28.5

Table 1. Abundance of predominant organisms found on the rock platform (number of organisms present/m^2, n = 20).

Major Study

The ephemeral species *S. lomentaria* and *E. intestinalis* were the dominant recolonising algae

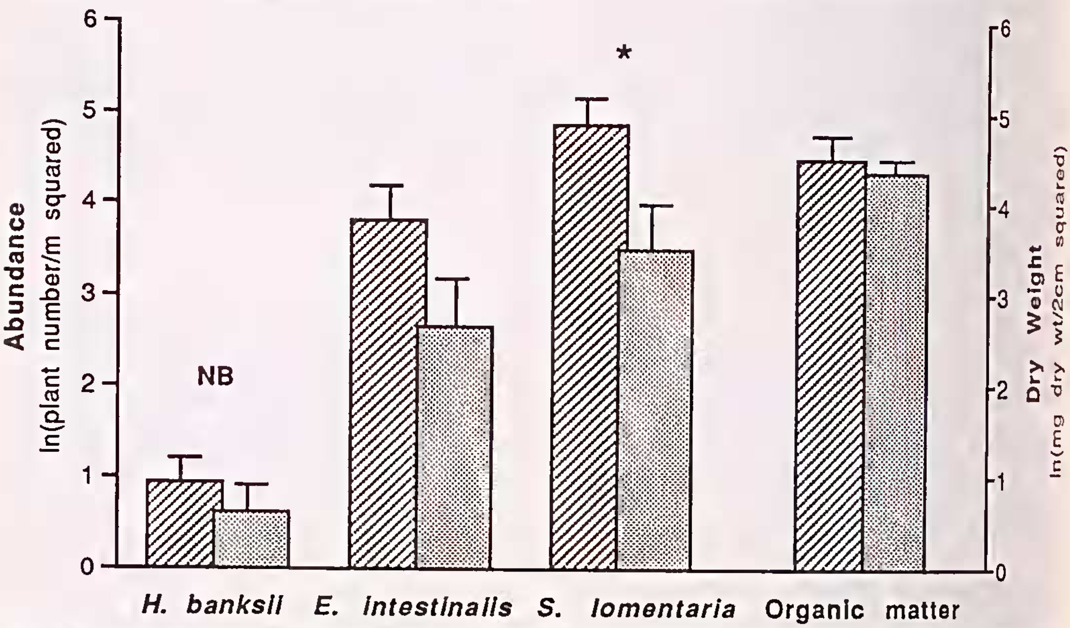

Fig. 1. Abundance of algae and dry weight of organic matter after 8 weeks following clearing of experimental areas in inclusion (diagonal rule) versus exclusion (stipple) areas. NB, analysis of *H. banksii* not performed due to the large number of null values; * = significant value of p ($p < 0.05$); inclusion = areas containing *B. nanum*; exclusion = areas where *B. nanum* excluded.

found during this experiment, covering 80–100% of the substratum in control areas and approximately 50% in test areas (those containing *B. nanum*) after 8 weeks growth (Fig. 1). Over the experimental period, *H. banksii* regrowth was greatest after 3 weeks; subsequently the number of *H. banksii* plants decreased.

The results of the analysis of variance show that *B. nanum* exhibited a significant ($F = 5.90$; $df = 1,18$; $p = 0.026$) inhibition on the recolonisation of *S. lomentaria*. No significant effect of *B. nanum* upon *E. intestinalis* ($F = 3.15$; $df = 1,18$; $P = 0.084$) recolonisation or upon total organic matter ($F = 0.2$; $df = 1,18$; $P = 0.646$) was seen in this experiment. Insufficient numbers of *H. banksii* were found in the recolonisation experiment for analysis.

DISCUSSION

In this study *B. nanum* exhibited a significant negative effect on the recolonisation of *S. lomentaria* over the intertidal platform during the period mid April to early June. This phenomenon may also indirectly alter the recolonisation of other species of algae (Lubchenco 1983, Underwood 1980, Underwood and Jernakoff 1981). It has been previously noted (Quinn & Ryan 1989, Underwood 1980, 1984) that *B. nanum* grazes on ephemeral algae, such as *Ulva* spp., and on microalgae. Quinn & Ryan (1989) also observed *B. nanum* grazing upon *E. intestinalis* and *S. lomentaria* in a study conducted during winter and spring, but no evidence was given that *B. nanum* is able to restrict numbers of colonizing *S. lomentaria*.

In the present study, no direct significant effects of *B. nanum* upon *E. intestinalis* or *H. banksii* were observed. It is feasible, however, that grazers may reduce the numbers of the most competitively aggressive algal species. An initial recolonisation of the perennial *H. banksii*, which subsequently became overgrown by the opportunistic ephemeral species *S. lomentaria* and *E. intestinalis*, suggests that grazing gastropods such as *B. nanum* may enhance the recolonisation of *H. banksii* over a longer period. Despite the reduction in the number of *S. lomentaria* in areas where *B. nanum* was present, no significant reduction of total organic matter was observed. Since the organic matter was measured in the central region of each experimental area, this latter result may reflect the patchy nature of the recolonisation of the algae rather than an effect of grazing. A longer study may clarify these points.

Experimental areas were bounded by a layer of antifouling paint (adjusted to 25% $CuSo_4$). The toxic effects of copper are believed to repel gastropods and prevent them from crossing a barrier of such paint (Cubit 1984). Antifouling paint was used in preference to cages in order to alleviate cage effects such as a reduction in wave and wind action, shading and harbouring of water and food particles (Cubit 1984, Underwood 1980). These microclimatic changes may also be compounded by the growth of algae on cages and by the presence of roofs on cages (Underwood 1980). Antifouling paint did not prevent *B. nanum* leaving the enclosures, and missing animals were replaced when necessary, although no *B. nanum* entered the control areas. Loss of animals from test areas was greater in the lower zones and may have been due to increased wave action and immersion in these zones.

In conclusion, *B. nanum* has been seen to exert a significant effect over the recolonisation of the ephemeral brown alga *Scytosiphon lomentaria* in the late autumn to early winter period in Victoria. *B. nanum* thus plays a recognizable role in the structure of this intertidal community.

ACKNOWLEDGEMENTS

We thank B. Newton for typing the manuscript.

REFERENCES

Cubit, J. D., 1984. Herbivory and the seasonal abundance of algae on a high intertidal rocky shore. *Ecology* 65: 1904–1917.

Fletcher, W. J. & Underwood, A. J., 1987. Interspecific competition among subtidal limpets: effects of substratum heterogeneity. *Ecology* 68: 387–400.

Fletcher, W. J. & Creese, R. G., 1985. Competetive interactions between co-occurring herbivorous gastropods. *Marine Biology* 86: 183–191.

Hunter, R. D. & Russell-Hunter, W. D., 1983. Bioenergetic and community changes in intertidal Aufwuchs grazed by *Littorina littorea*. *Ecology* 64: 761–769.

Jernakoff, P., 1983. Factors affecting the recruitment of algae in a midshore region dominated by barnacles. *Journal of Experimental Marine Biology and Ecology* 67: 17–31.

Lubchenco, J., 1980. Algal zonation in the New England rocky intertidal community: an experimental analysis. *Ecology* 61: 333–344.

Lubchenco, J., 1983. *Littorina* and *Fucus*; effects of herbivores, substratum heterogeneity, and plant escapes during succession. *Ecology* 64: 1116–1123.

LUBCHENCO, J. & CUBIT, J. O., 1980. Heteromorphic life histories of certain marine algae as adaptions to variations in herbivory. *Ecology* 61: 676–687.

QUINN, G. P. & RYAN, N. R., 1989. Competitive interactions between two species of intertidal herbivorous gastropods from Victoria, Australia. *Journal of Experimental Marine Biology and Ecology* 125: 1–12.

STENECK, R. S., 1982. A limpet coralline alga association. Adaptions between a selective herbivore and its prey. *Ecology* 63: 507–522.

UNDERWOOD, A. J., 1980. Effects of grazing by gastropods and physical factors on the upper limits of distribution of intertidal macroalgae. *Oecologia* (Berlin) 46: 201–213.

UNDERWOOD, A. J., 1984. Vertical and seasonal patterns in competition for microalgae between intertidal gastropods. *Oecologia* (Berlin) 64: 211–222.

UNDERWOOD, A. J. & JERNAKOFF, P., 1981. Effects of interactions between algae and grazing gastropods on the structure of a low shore intertidal community. *Oecologia* (Berlin) 48: 221–233.

ZAR, J. H., 1984. *Biostatistical Analysis*, 2nd edn, Engleworth Cliffs: Prentice Hall.